Faglig notat

New nickel, copper and platinum-group element discoveries in northern Norway

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Nordic Mining’s exploration in the Seiland Igneous Province in Northern Norway has led to the discovery of new magmatic nickel, copper, cobalt and platinum/palladium/gold mineralizations in the Reinfjord and Lokkarfjord areas on the Øksfjord Peninsula. An exploration drilling program has been carried out in the Reinfjord Ultramafic Intrusion. A mineralization carrying economically interesting grades of base and precious metals was discovered at approximately 100 meters depth.

I. THE SEILAND IGNEOUS PROVINCE

The Øksfjord Peninsula is part of The Seiland Igneous Province (SIP) known for its 5,500 km² of mafic and ultramafic intrusions comprising 75% by area. The remaining 25 % of SIP consists of calc-alkaline and alkaline igneous plutons (figure 1). Zircon U/Pb geochronology implies that SIP was formed between 560 and 570 Million years ago and that the mafic intrusions were emplaced in less than 4 million years (Roberts 2007). It has been suggested that SIP represents the deep seated parts of a large magmatic pluming system, that, on the surface, may have fed massive volcanic outpouring systems comparable to for example the Siberian Trap and the North Atlantic Volcanic Province (Larsen et al. 2012).
2. EXPLORATION HISTORY

The Seiland Igneous Province is to a large extent unexplored for high-end minerals though erratic base metal findings have been reported in early exploration reports from the 1970’sies. Nordic Mining has carried out fieldwork and sampling in several areas of interest within the complex (Often and Schiellerup 2008, Iljina 2011). The Reinfjord and Lokkarfjord intrusions were further investigated by airborne geophysics (electromagnetic and magnetic measurements), carried out by SkyTEM, in July 2011. An expert review of the data by Revelation Geosciences Ltd revealed two conductive bodies side by side in the Reinfjord Intrusion, and four targets within the Lokkarfjord intrusion (Johnson 2011).

Nordic Mining prioritised the Reinfjord for further investigations and a ground electromagnetic survey (TEM) was completed in early 2012. The result of the survey confirmed that a sizeable conductor was present in Reinfjord at
approximately 100 meters depth (Thunehed 2012). Exploration drilling was then carried out in May 2012. The drilling lead to the discovery of Ni, Cu, Co, PGE and gold (Au) enriched sulphide mineralizations between 86 and 116 meters fitting well with the interpreted conductors.

3. THE REINFJORD GEOLOGY

The Reinfjord Intrusion is situated in the Kvænangen municipality in Troms County. The target area is located at an altitude of approximately 600 meters above sea level about 2.5 km from the coastline and the Reinfjord village.

Figure 2. Geological map of the Reinfjord Intrusion (Nerhus Øen og Anker-Rasch 2011)
Figure 2 shows the geology of the Reinfjord Intrusion. The ultramafic intrusion is bordered by gabbro in the east and garnet gneiss in the west. The central intrusion consists of layered olivine-pyroxenites and wherlite/dunites (The Layered Series) and a slightly younger dunite (The Central Series). There are evidences of partial melting and assimilation of wallrock along the intrusion in The Marginal Series. Uneconomic disseminated Ni/Cu mineralizations depleted in PGE-Au are found several places exposed along the Marginal Series. These seem to be “Contact type” mineralizations formed by the country rock contamination and are known as the Småvatna and Bonjikdalen mineralizations (Søyland Hansen 1971, Iljina 2011).

Figure 3. Overview of the upper part of the Reinfjord intrusion. The Langfjordjøkelen glacier is seen in the far distance

4. THE REINFJORD Ni/Cu/PGE MINERALIZATION

Modeling by Geovista AB of ground TEM measurements produced a 600*600 meters wide conductive body. The model showed a conductor to be located between 60 and 110 meters depth. The conductor is a flat lying, open bowl shaped structure dipping gently towards the northeast. Figure 4 shows the interpreted 3D model (Thunehed 2012).
Nordic Mining conducted a drilling program in May 2012 of two drill holes to 243 and 169 meters in depth. The drill holes were planned to intersect the modeled conductor.

Drill hole RF-1 intersected two zones of disseminated sulphides. A Nickel/Copper rich zone is underlain by a more PGE+Au enriched zone. The PGE zone shows characteristic pegmatitic texture with coarse grained pyroxene, blue quartz and
plagioclase. The table below presents the average base and precious metal contents for the best mineralized sections in drill hole RF-1.

**Table 1.** Average base & precious metal contents for the best mineralized sections in drill hole RF-1.

<table>
<thead>
<tr>
<th>Hole ID</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Dist. (m)</th>
<th>Ni (%)</th>
<th>Cu (%)</th>
<th>Co (%)</th>
<th>Au (g/t)</th>
<th>Pd (g/t)</th>
<th>Pt (g/t)</th>
<th>PGE+Au (g/t)</th>
<th>S (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-1</td>
<td>86</td>
<td>93</td>
<td>7</td>
<td>0.38</td>
<td>0.12</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.09</td>
<td>0.61</td>
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<tr>
<td>RF-1*</td>
<td>107.75</td>
<td>117</td>
<td>9.25</td>
<td>0.27</td>
<td>0.06</td>
<td>0.02</td>
<td>0.07</td>
<td>0.20</td>
<td>0.15</td>
<td>0.42</td>
<td>0.58</td>
</tr>
<tr>
<td>*including</td>
<td>107.75</td>
<td>113</td>
<td>5.25</td>
<td>0.24</td>
<td>0.05</td>
<td>0.01</td>
<td>0.10</td>
<td>0.31</td>
<td>0.23</td>
<td>0.64</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Microscope observations show that interstitial pentlandite and chalcopyrite are ore forming minerals in drill hole RF-1, see figure 6 below.

*Figure 6. Microscope pictures of RF-1 sulphides, dark brownish yellow is chalcopyrite, light yellow is pentlandite and pyrrhotite is creamish brown.*

Field observations show evidences of magma replenishment while geochemical studies of drill cores indicate magma injections of variable compositions. The presence of evolved or contaminated magma and/or fluids has also resulted in pegmatitic textures and formation of felsic minerals.

Drill hole RF-2 shows a more complex lithology with cross-cutting younger intrusive phases. Disseminated sulphides are found especially between 94 and 116 meters. The Ni, Cu and PGE grades are somewhat lower than for drill hole RF-1 and the pegmatitic rock hosting the PGE enriched interval in drill hole RF-1 is not found in drill hole RF-2.

The table below shows the average base and precious metal contents in the best mineralized section in drill hole RF-2.
Table 2. Average base & precious metal contents for the best mineralized sections in drill hole RF-2.

<table>
<thead>
<tr>
<th>Hole ID</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Dist. (m)</th>
<th>Ni (%)</th>
<th>Cu (%)</th>
<th>Co (%)</th>
<th>Au (g/t)</th>
<th>Pd (g/t)</th>
<th>Pt (g/t)</th>
<th>PGE+Au (g/t)</th>
<th>S (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-2</td>
<td>94</td>
<td>116</td>
<td>22</td>
<td>0.29</td>
<td>0.05</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.06</td>
<td>0.36</td>
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</tbody>
</table>

Chalcopyrite, cubanite, native copper, and pentlandite (Fig. 7) were identified as ore forming minerals in drill hole RF-2.

Figure 7. RF-2 sulphides - Native copper (orange red) in Cubanite (CuFe$_2$S$_3$) in right picture and chalcopyrite in left. Cubanite and native copper is an alteration product of chalcopyrite.

Nordic Mining will put effort into understanding the relationship between the geological setting, the mineralized intervals and the modelled conductor. Whole-rock chemical analyses will be done to better characterize the various rock units. The current exploration model is that the Ni, Cu, PGE deposit is related to magma replenishments and concentration of fluids in the root/feeder area of the magmatic pluming system.

5. THE LOKKARFJORD MINERALISATION

Lokkarfjord is a smaller hornblendite intrusion located in the so called “Sulphur Mountain” (Svovelberget) in the municipality of Alta, on the northern part of the Øksfjord Peninsula. The Lokkarfjord intrusion is bordered by older gabbro to the south and the sea to the north. Two massive sulphide bodies have been documented in historic exploration reports on the steep slope close to the sea. The airborne geophysics in the area picked these mineralizations as well as three other spot-like conductors on the slope side. The usage of airborne geophysics was greatly hampered by the steep hill slope as the Lokkarfjord intrusion raises 600 m almost vertically from the sea.
Nordic Mining’s fieldwork in 2011 comprised of sampling of massive sulphide boulders dropped from the higher levels of the slope and a sample profile along the shore line (Iljina 2011).

![Sampling profile in Lokkarfjord Intrusion (Iljina 2011).](image)

Analysis of the sulphide mineralization shows ore grade base and precious metal values. The values for the two best samples are shown in the table below.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Ni (%)</th>
<th>Cu (%)</th>
<th>Co (%)</th>
<th>Au (g/t)</th>
<th>Pd (g/t)</th>
<th>Pt (g/t)</th>
<th>PGE+Au (g/t)</th>
<th>S (%)</th>
</tr>
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<tbody>
<tr>
<td>L1</td>
<td>0.55</td>
<td>1.83</td>
<td>0.04</td>
<td>0.16</td>
<td>1.01</td>
<td>0.14</td>
<td>1.31</td>
<td>11.9</td>
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<tr>
<td>L1003</td>
<td>1.20</td>
<td>0.97</td>
<td>0.10</td>
<td>0.11</td>
<td>0.64</td>
<td>0.18</td>
<td>0.93</td>
<td>12.5</td>
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</tbody>
</table>

Nordic Mining will continue investigation of the sulphide bodies in the Lokkarfjord intrusion. More sampling, field investigations and appropriate ground geophysical measurements are warranted.
REFERENCES


